

IN THE CLAIMS:

- 1 1. (Previously Presented) A method for operating a storage system,
2 comprising:
 - 3 initiating writing a first consistency point (CP) at a first time, a CP being a wholly
4 consistent and up-to-date version of an old data of the file system which is written to
5 persistent storage, the old data received by the storage system since an earlier CP was written
6 to persistent storage, and the old data stored in an old buffers in memory of the storage
7 system;
 - 8 determining a first consistency point number assigned to the first CP, the first CP
9 number to identify the old buffers as holding data to be written to persistent storage during
10 the first CP;
 - 11 receiving a write operation to add new data to the storage system, the write operation
12 identifying a file for the write operation to store the new data, the new data written to a new
13 buffer in memory of the storage system;
 - 14 continuing to receive write operations for the new data during writing the first CP, the
15 new data to be written to a second CP at a later second time, the new data written to a new
16 data buffers in memory of the storage system;
 - 17 determining that a volume storing the file has buffer leakage detection activated;
18 while writing the new data to the new data buffers, and in response to determining
19 that the volume has buffer leakage detection activated, writing a buffer check control
20 structure to the new data buffer, the buffer check control structure including one or more
21 uniquely identifying numbers referred to as magic numbers, and an identifying consistency
22 point number, the magic numbers to uniquely identify the new data buffer as a labeled buffer
23 check control structure and to indicate that the data buffer needs to be checked for leakage;
24 and
 - 25 comparing a buffer consistency point number read from an old buffer with the first
26 consistency point number, the magic numbers to identify the buffer check control structure
27 containing the buffer consistency point number, and if the buffer consistency point number

28 agrees with the first consistency point number, continuing to write the first consistency point,
29 and continuing to write the new data to the new data buffers, and

30 in the event that the buffer consistency point number disagrees with the first
31 consistency point number, signaling an administrator that buffer leakage between consistency
32 points has occurred, and halting writing of the first consistency point, and halting write
33 operations to add new data to the storage system.

1 2. (Previously Presented) The method of claim 1 wherein the step of creating the data buffer
2 further comprises:

3 creating the buffer check control structure and the raw data buffer.

1 3. (Previously Presented) The method of claim 2 wherein the buffer check control structure
2 comprises a pointer to the raw data buffer.

1 4. (Previously Presented) The method of claim 1 wherein the step of writing the buffer check
2 control structure to the raw data buffer further comprises:

3 creating the buffer check control structure; and

4 overwriting a portion of the raw data buffer with the buffer check control structure.

1 5. (Previously Presented) The method of claim 1 wherein the step of writing the buffer check
2 control structure to the raw data buffer further comprises:

3 creating the buffer check control structure; and

4 associating the buffer check control structure to the raw data buffer in a contiguous
5 block of memory.

1 6. (Previously Presented) The method of claim 1 wherein the magic numbers uniquely
2 identify a particular buffer check control structure.

1 7. (Previously Presented) The method of claim 1 wherein the one or more magic numbers
2 comprises a 64-bit number.

1 8. (Previously Presented) The method of claim 1 wherein the one or more magic numbers
2 comprises two 32-bit numbers.

1 9. (Previously Presented) The method of claim 1 wherein the consistency point number
2 identifies a current consistency point.

1 10. (Previously Presented) The method of claim 1 wherein the consistency point number
2 comprises a 32-bit number.

1 11. (Previously Presented) A method for detecting leaked buffer writes between a first
2 consistency point and a second consistency point, comprising:
3 initiating writing a first consistency point (CP) at a first time, a CP being a wholly
4 consistent and up-to-date version of an old data of the file system which is written to
5 persistent storage, the old data received by the storage system since an earlier CP was written
6 to persistent storage, and the old data stored in an old buffer in memory of the storage
7 system;

8 determining a first consistency point number assigned to the first CP, the first CP
9 number to identify the old buffers as holding data to be written to persistent storage during
10 the first CP;

11 selecting an old data buffer;

12 determining if one or more uniquely identifying numbers (hereinafter magic numbers)
13 are within the old data buffer, the magic numbers to uniquely identify the old data buffer as
14 having a labeled buffer check control structure and to indicate that the old data buffer needs
15 to be checked for leakage;

16 reading an identifying consistency point number from the labeled buffer check
17 control structure;

18 receiving a write operation to add new data to the storage system, the new data to be
19 written to a second CP at a later second time, the new data written to a new data buffer in
20 memory of the storage system;

21 comparing a buffer consistency point number read from the old buffer with the first
22 consistency point number, and if the buffer consistency point number agrees with the first
23 consistency point number, continuing to write the first consistency point, and continuing to
24 write the new data to the new data buffer, and

25 in the event that the buffer consistency point number disagrees with the first
26 consistency point number, signaling an administrator that buffer leakage between consistency
27 points has occurred, and halting writing of the first consistency point, and halting write
28 operations to add new data to the storage system.

1 12. (Cancelled).

1 13. (Previously Presented) The method of claim 11 wherein the one or more magic numbers
2 comprise a 64-bit magic number.

1 14. (Previously Presented) The method of claim 11 wherein the one or more magic numbers
2 further comprises two 32-bit magic numbers.

1 15. (Previously Presented) The method of claim 11 wherein the step of determining if the
2 consistency point number is correct further comprises:

3 determining if the consistency point number within the buffer check control structure
4 equals a consistency point number identifying a current consistency point.

1 16. (Previously Presented) The method of claim 11 wherein the step of performing a write
2 operation further comprises:

3 writing a set of raw data within the data buffer to a disk.

1 17. (Original) The method of claim 16 wherein the raw data comprises the buffer check
2 control structure.

1 18. (Previously Presented) The method of claim 16 wherein the step of performing the write
2 operation further comprises:

3 removing the buffer check control structure from the raw data before writing the file
4 system buffer to disk.

1 19. (Previously Presented) The method of claim 16 wherein the step of performing the write
2 operation comprises:

3 writing only the raw data within the file system buffer to disk.

1 20-21. (Cancelled)

1 22. (Previously Presented) A computer storage system apparatus, comprising:

2 a storage operating system executing on the storage system to write a first consistency
3 point (CP) at a first time, a CP being a wholly consistent and up-to-date version of an old
4 data of the file system which is written to persistent storage, the old data received by the
5 storage system since an earlier CP was written to persistent storage, and the old data stored in
6 an old data buffer in memory of the storage system;

7 the storage operating system to determine a first consistency point number assigned to
8 the first CP, the first CP number to identify the old buffers as holding data to be written to
9 persistent storage during the first CP;

10 a write operation received by the storage system, the write operation identifying a
11 file for the write operation to be performed on;

12 the storage operating system to determine that a volume storing the file has buffer
13 leakage detection activated;

14 a new data buffer created to store new data from the write operation; and

15 the storage operating system to compare a buffer consistency point number read from
16 an old buffer with the first consistency point number, and if the buffer consistency point
17 number agrees with the first consistency point number, continuing to write the first
18 consistency point, and continuing to write the new data to the new data buffer, and

19 in the event that the buffer consistency point number disagrees with the first
20 consistency point number, signaling an administrator that buffer leakage between consistency
21 points has occurred, and halting writing of the first consistency point, and halting write
22 operations to add new data to the storage system.
23

1 23. (Previously Presented) The apparatus of claim 22 wherein the data buffer created to
2 associate with the write operations comprises the buffer check control structure and the raw
3 data buffer.

1 24. (Previously Presented) The apparatus of claim 23 wherein the buffer check control
2 structure comprises a pointer to the raw data buffer.

1 25. (Previously Presented) The apparatus of claim 22 wherein the buffer check control
2 structure to write to a raw data buffer associated with the data buffer further comprises the
3 buffer check control structure to overwrite a portion of the raw data buffer.

1 26. (Previously Presented) The apparatus of claim 22 wherein the buffer check control
2 structure to write to the raw data buffer further comprises the buffer check control structure
3 to associate with the raw data buffer in a contiguous block of memory.

1 27. (Cancelled).

1 28. (Previously Presented) The apparatus of claim 22 wherein the one or more magic
2 numbers comprises a 64-bit number.

1 29. (Previously Presented) The apparatus of claim 22 wherein the one or more magic
2 numbers comprises two 32-bit numbers.

1 30. (Previously Presented) The apparatus of claim 22 wherein the consistency point number
2 is configured to identify a current consistency point.

1 31. (Previously Presented) The system of claim 22 wherein the consistency point number
2 comprises a 32-bit number.

1 32. (Previously Presented) A method for operating a computer storage system, comprising:

2 initiating writing a first consistency point (CP) at a first time, a CP being a wholly
3 consistent and up-to-date version of an old data of the file system which is written to
4 persistent storage, the old data received by the storage system since an earlier CP was written
5 to persistent storage, and the old data stored in an old buffer in memory of the storage
6 system;

7 determining a first consistency point number assigned to the first CP, the first CP
8 number to identify the old buffers as holding data to be written to persistent storage during
9 the first CP;

10 receiving a write operation, wherein the write operation identifies a data container for
11 the write operation to store a new data in, the new data to be written to a second CP at a later
12 second time, the new data written to a new data buffer in memory of the storage system;

13 determining that a volume storing the data container has buffer leakage detection
14 activated;

15 reading an identifying consistency point number from a labeled buffer check control
16 structure read from the old buffer;

17 comparing a buffer consistency point number read from the old buffer with the first
18 consistency point number, and if the buffer consistency point number agrees with the first
19 consistency point number, continuing to write the first consistency point, and continuing to
20 write the new data to the new data buffer, and

21 in the event that the buffer consistency point number disagrees with the first
22 consistency point number, signaling an administrator that buffer leakage between consistency
23 points has occurred, and halting writing of the first consistency point, and halting write
24 operations to add new data to the storage system.

1 33. (Previously Presented) The method of claim 32, wherein the data container is a virtual
2 disk or a file.

1 34. (Previously Presented) The method of claim 32, wherein the first consistency point is the
2 current consistency point.

1 35. (Previously Presented) The method of claim 32, wherein the step of creating the data
2 buffer further comprises:

3 creating the buffer check control structure and the raw data buffer.

1 36. (Previously Presented) The method of claim 32, wherein the step of writing the buffer
2 check control structure to the raw data buffer further comprises:

3 creating the buffer check control structure; and

4 overwriting a portion of the raw data buffer with the buffer check control structure.

1 37. (Previously Presented) The method of claim 32, wherein the step of writing the buffer
2 check control structure to the raw data buffer further comprises:

3 creating the buffer check control structure; and

4 associating the buffer check control structure to the raw data buffer in a contiguous
5 block of memory.

1 38. (Previously Presented) A method for detecting leaked buffer writes between a first
2 consistency point and a second consistency point, the method comprising:

3 initiating writing a first consistency point (CP) at a first time, a CP being a wholly
4 consistent and up-to-date version of an old data of the file system which is written to
5 persistent storage, the old data received by the storage system since an earlier CP was written
6 to persistent storage, and the old data stored in an old buffer in memory of the storage
7 system;

8 determining a first consistency point number assigned to the first CP, the first CP
9 number to identify the old buffers as holding data to be written to persistent storage during
10 the first CP;

11 selecting an old data buffer;

12 reading an identifying consistency point number from the old buffer;

13 receiving a write operation, the write operation identifying a file for the write
14 operation to write new data into, the new data to be written to a second CP at a later second
15 time, the new data written to a new data buffer in memory of the storage system;

16 comparing the identifying consistency point number from the old buffer with the first
17 consistency point number, and if the identifying consistency point number agrees with the
18 first consistency point number, continuing to write the first consistency point, and continuing
19 to write the new data to the new data buffer, and

20 in the event that the buffer consistency point number disagrees with the first
21 consistency point number, signaling an administrator that buffer leakage between consistency
22 points has occurred, and halting writing of the first consistency point, and halting write
23 operations to add new data to the storage system.

1 39. (Previously Presented) The method of claim 38 further comprising:

2 creating the buffer check control structure and the raw data buffer.

1 40. (Previously Presented) The method of claim 39 further comprising:

2 writing a pointer to the raw data buffer into the buffer check control structure.

1 41. (Previously Presented) The method of claim 38 further comprising:

2 creating the buffer check control structure; and

3 overwriting a portion of the raw data buffer with the buffer check control structure.

1 42. (Previously Presented) The method of claim 38 further comprising:

2 creating the buffer check control structure; and

3 associating the buffer check control structure to the raw data buffer in a contiguous
4 block of memory.

1 43. (Previously Presented) The method of claim 38 further comprising:
2 uniquely identifying a particular buffer check control structure by the magic numbers.

1 44. (Previously Presented) The method of claim 38 further comprising:
2 using a 64-bit number as the one or more magic numbers.

1 45. (Previously Presented) The method of claim 38 further comprising:
2 using two 32-bit numbers as the one or more magic numbers.

1 46. (Previously Presented) The method of claim 38 further comprising:
2 identifying a current consistency point by the consistency point number.

1 47. (Previously Presented) The method of claim 38 further comprising:
2 using a 32-bit number as the consistency point number.

1 48. (Cancelled)

1 49. (Previously Presented) The method of claim 11, further comprising:
2 detecting buffer leakage in response to determining that the one or more magic
3 numbers within the buffer check control structure are correct and that the consistency
4 point number is not correct.

1 50. (Previously Presented) A method for operating a computer storage system,
2 comprising:
3 initiating writing a first consistency point (CP) at a first time, a CP being a wholly
4 consistent and up-to-date version of an old data of the file system which is written to

5 persistent storage, the old data received by the storage system since an earlier CP was written
6 to persistent storage, and the old data stored in an old buffer in memory of the storage
7 system;

8 determining a first consistency point number assigned to the first CP, the first CP
9 number to identify the old buffers as holding data to be written to persistent storage during
10 the first CP;

11 reading an identifying consistency point number from the old data buffer;

12 receiving a write operation to add new data to the storage system, the new data to be
13 written to a second CP at a later second time, the new data written to a new data buffers in
14 memory of the storage system; and

15 comparing a buffer consistency point number read from an old buffer with the first
16 consistency point number, and if the buffer consistency point number agrees with the first
17 consistency point number, continuing to write the first consistency point, and continuing to
18 write the new data to the new data buffer, and

19 in the event that the buffer consistency point number disagrees with the first
20 consistency point number, signaling an administrator that buffer leakage between consistency
21 points has occurred, and halting writing of the first consistency point, and halting write
22 operations to add new data to the storage system.

1 51. (Previously Presented) The method as in claim 50, further comprising:

2 reading a buffer check control structure from the old data buffer, the buffer check
3 control structure including one or more uniquely identifying numbers referred to as magic
4 numbers and the identifying consistency point number, the magic numbers to uniquely
5 identify the new data buffer as a buffer check control structure.

1 52. (Previously Presented) The method as in claim 50, further comprising:

2 writing a buffer check control structure into the new data buffer, the buffer check
3 control structure including one or more uniquely identifying numbers referred to as magic
4 numbers and a new consistency point number, the magic numbers to uniquely identify the
5 new data buffer as a buffer check control structure and the new consistency point number to

6 identify the buffer as to be written to persistent storage during writing the second consistency
7 point at the second time.

1 53. (Previously Presented) The method as in claim 50, further comprising:
2 in response to reading a reading one or more uniquely identifying numbers referred to
3 as magic numbers from the old data buffer, identifying a buffer check control structure, the
4 buffer check control structure including the identifying consistency point number from the
5 old data buffer.

1 54. (Previously Presented) The method as in claim 53, further comprising:
2 in response to reading the one or more uniquely identifying numbers referred to as
3 magic numbers from the old data buffer, determining that a volume storing the data has
4 buffer leakage detection activated.

1 55. (Previously Presented) The method as in claim 50, further comprising:
2 continuing to receive write operations for the new data during writing the first CP.

1 56. (Previously Presented) A computer storage system, comprising:
2 a storage operating system executing on the storage system to write a first consistency
3 point (CP) at a first time, a CP being a wholly consistent and up-to-date version of an old
4 data of the file system which is written to persistent storage, the old data received by the
5 storage system since an earlier CP was written to persistent storage, and the old data stored in
6 an old buffer in memory of the storage system;
7 the storage operating system to determine a first consistency point number assigned to
8 the first CP, the first CP number to identify the old buffers as holding data to be written to
9 persistent storage during the first CP;
10 the storage operating system to read an identifying consistency point number from the
11 old data buffer;

12 the storage system to receive a write operation to add new data to the storage system,
13 the new data to be written to a second CP at a later second time, the new data written to a
14 new data buffer in memory of the storage system; and

15 the storage operating system to compare a buffer consistency point number read from
16 an old buffer with the first consistency point number, and if the buffer consistency point
17 number agrees with the first consistency point number, continuing to write the first
18 consistency point, and continuing to write the new data to the new data buffer, and

19 in the event that the buffer consistency point number disagrees with the first
20 consistency point number, signaling an administrator that buffer leakage between consistency
21 points has occurred, and halting writing of the first consistency point, and halting write
22 operations to add new data to the storage system.

1 57. (Previously Presented) The computer storage system as in claim 56, further comprising:

2 a buffer check control structure read from the old data buffer, the buffer check control
3 structure including one or more uniquely identifying numbers referred to as magic numbers
4 and the identifying consistency point number, the magic numbers to uniquely identify the
5 new data buffer as a buffer check control structure.

1 58. (Previously Presented) The computer storage system as in claim 56, further comprising:

2 a buffer check control structure to be written into the new data buffer, the buffer
3 check control structure including one or more uniquely identifying numbers referred to as
4 magic numbers and a new consistency point number, the magic numbers to uniquely identify
5 the new data buffer as a buffer check control structure and the new consistency point number
6 to identify the buffer as to be written to persistent storage during writing the second
7 consistency point at the second time.

1 59. (Previously Presented) The computer storage system as in claim 56, further comprising:

2 in response to reading a reading one or more uniquely identifying numbers referred to
3 as magic numbers from the old data buffer, identifying a buffer check control structure, the

4 buffer check control structure including the identifying consistency point number from the
5 old data buffer.

1 60. (Previously Presented) The computer storage system as in claim 59, further comprising:
2 in response to reading the one or more uniquely identifying numbers referred to as
3 magic numbers from the old data buffer, the computer storage system to determine that a
4 volume storing the data has buffer leakage detection activated.

1 61. (Previously Presented) The computer storage system as in claim 56, further comprising:
2 the computer storage system to continue to receive write operations for the new data
3 during writing the first CP.

1 62. (Previously Presented) A computer readable storage media, comprising:
2 said computer readable storage media containing instructions for execution on a
3 processor for a method of operating a computer storage system, having,
4 initiating writing a first consistency point (CP) at a first time, a CP being a wholly
5 consistent and up-to-date version of an old data of the file system which is written to
6 persistent storage, the old data received by the storage system since an earlier CP was written
7 to persistent storage, and the old data stored in an old buffer in memory of the storage
8 system;
9 determining a first consistency point number assigned to the first CP, the first CP
10 number to identify the old buffers as holding data to be written to persistent storage during
11 the first CP;
12 reading an identifying consistency point number from the old data buffer;
13 receiving a write operation to add new data to the storage system, the new data to be
14 written to a second CP at a later second time, the new data written to a new data buffers in
15 memory of the storage system; and
16 comparing a buffer consistency point number read from an old buffer with the first
17 consistency point number, and if the buffer consistency point number agrees with the first

18 consistency point number, continuing to write the first consistency point, and continuing to
19 write the new data to the new data buffer, and
20 in the event that the buffer consistency point number disagrees with the first
21 consistency point number, signaling an administrator that buffer leakage between consistency
22 points has occurred, and halting writing of the first consistency point, and halting write
23 operations to add new data to the storage system.